NUI Galway
OÉ Gaillimh

Autumn Examinations 2016

Exam Code(s)	4BCT, 1SD, 1MF, 4BS
Exam(s)	4th Year B.Sc. (CS&IT) Higher Diploma in Applied Science (Software Design & Development) Masters in Software Design & Development 4th Year B.Sc.
Module Code(s)	CT404, CT336
Module(s)	Graphics and Image Processing
Paper No.	
Repeat Paper	
External Examiner(s)	Prof. L. Maguire Dr. J. Power
Internal Examiner(s)	Prof. G. Lyons Dr. J. Duggan * Dr. S. Redfern
Instructions:	Answer any three questions. All questions carry equal marks.
Duration	2 hours
No. of Pages	5
Discipline(s)	Information Technology
Course Co-ordinator(s)	

Requirements:

MCQ	Release to Library:	Yes	X	No
Handout				
Statistical/ Log Tables				
Cambridge Tables				
Graph Paper				
Log Graph Paper				
Other Materials				
Graphic material in colour	Yes		No	

PTO

Q.1. (Graphics)

(i) Explain the concept Nested Coordinate System as it applies to computer graphics. Why are nested coordinate systems useful? [6]

(ii) Provide short sections of code illustrating the use of nested coordinate systems in both Canvas/Javascript, and in X3D [8]

(iii) Antialiasing is an approach in 2D raster graphics, which uses colour (depth) as a means to simulate an increase in resolution. With reference to the 'G' figures illustrated below, discuss the antialiasing technique, and in particular the concept of sub-pixel accuracy. [6]

Q.2. (Graphics)

(i) Describe the use of extrusion in X3D, referring to each of the seven fields used by the Extrusion node. Note that extrusion and other useful nodes from the X3D language are summarised on the final page of this exam paper. **[5]**

(ii) Write X3D code to make a model of a coffee table (example illustrated on the right). **[15]**

- The model should be as geometrically accurate as possible (please provide sketches)
- The model should use a woodgrain texture as the material for its shapes. You can assume that a file called "wood.jpg" is available for this purpose.

Q.3. (Graphics)

(i) Many of the techniques used in real-time 3D graphics programming attempt to maximise the realism of the rendered scene while processing a minimal number of polygons. With specific reference to this 'polygon budget', and using diagrams where appropriate, discuss each of the following five techniques [15]

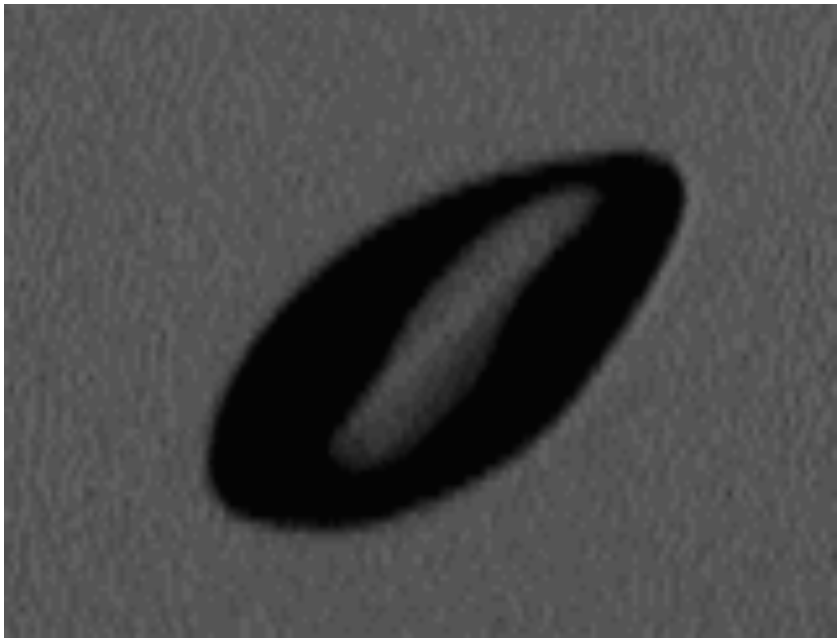
a) Frustum Culling
b) Bump Mapping
c) Binary Space Partitioning
d) Billboards
e) Levels-of-Detail (LODs)

(ii) Discuss the Lambert, Gourard and Phong Shading algorithms, illustrating your answer with diagrams [5]

Q.4. (Image Processing)

(i) Describe the morphological image processing techniques of erosion and dilation. Compare the four operations (a) opening, (b) closing, (c) thinning and (d) thickening. In what circumstances might each of these four operations be used? [10]

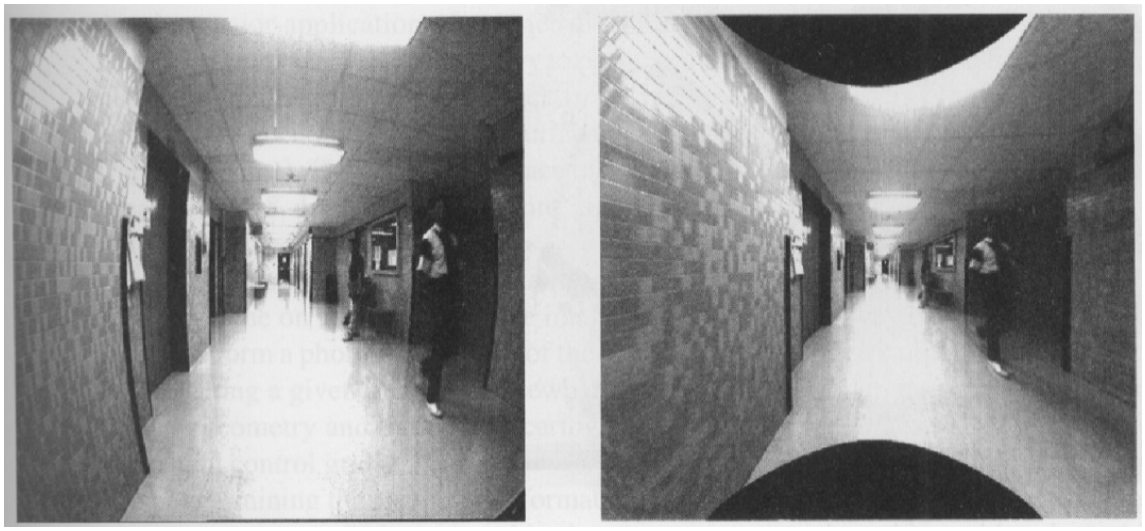
(ii) Consider the image of a bubble, shown below. The image contains substantial amounts of noise, and there exists a large section of bright 'shine' pixels across the centre of the bubble. Propose and justify a series of image processing steps that would be suitable to accurately measure the number of pixels inside the bubble. [10]



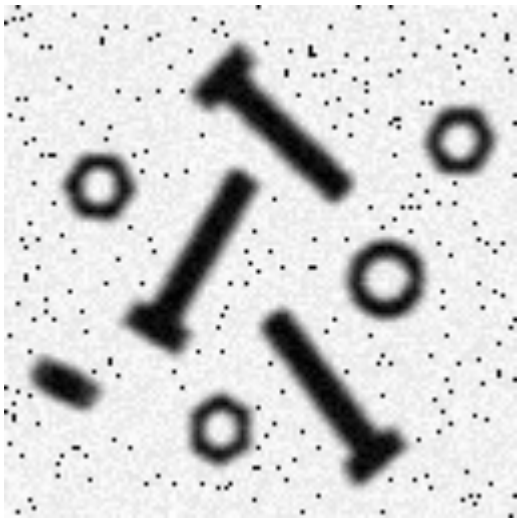
Q.5. (Image Processing)

(i) Camera decalibration is a technique for geometric correction of images which is often employed when sources of geometric error are poorly understood. With regard to camera decalibration:

- Outline the use of reference images such as grids of dots to construct and apply geometric corrections to images captured with a wide-angle lens (e.g. the image below). Use the terms 'control points', 'pixel filling', and 'bilinear interpolation' in your answer. [7]
- Explain why would you expect a reference image to be constructed with black markings on a white background (or white markings on a black background) [3]



(ii) Pictured below is a binary image which contains nuts and bolts as well as noise pixels. Outline and discuss an image processing algorithm for automatic isolation and counting of nuts and bolts in images such as this. [10]



Some useful X3D nodes:

Node	Important Fields and Nested Nodes
Shape	Nested Nodes: Appearance, Geometry Nodes (Box, Sphere, Cone, Cylinder, Text, Extrusion, etc.)
Appearance	Nested Nodes: Material, ImageTexture
Material	Fields: diffuseColor, specularColor, emissiveColor, ambientIntensity, transparency, shininess
ImageTexture	Fields: url
Transform	Fields: translation, rotation, scale, center. Nested Nodes: Other Transforms, Shapes, Sensors
TimeSensor	Fields: enabled, startTime, stopTime, cycleInterval, loop
PositionInterpolator	Fields: key, keyValue
OrientationInterpolator	Fields: key, keyValue
Extrusion	Fields: crossSection, spine, scale, orientation, beginCap, endCap, creaseAngle
Box	Fields: size
Sphere	Fields: radius
Cylinder	Fields: radius, height, side, top, bottom
Cone	Fields: height, bottomRadius, side, bottom
PointLight	Fields: on, location, radius, intensity, ambientIntensity, color, attenuation
ROUTE	Fields: fromNode, fromField, toNode, toField

Some useful methods/properties of the Canvas 2D Context object:

Method/Property	Arguments/Values	Notes
fillRect	(Left, Top, Width, Height)	Draw a filled rectangle
beginPath	None	Start a stroked path
moveTo	(X, Y)	Move the graphics cursor
lineTo	(X, Y)	Draw a line from graphics cursor
stroke	None	End a stroked path
fillStyle	="rgb(R,G,B)"	Set fill colour
strokeStyle	="rgb(R,G,B)"	Set line colour
save	None	Save the current coordinate system
restore	None	Restore the last saved coord system
translate	(X,Y)	Translate the coordinate system
rotate	(angle)	Rotate the coordinate system clockwise, with angle in radians
scale	(X,Y)	Scale the coordinate system independently on the X and Y axes